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Performance Evaluation and OMPAT Data and Timing Support
Programs

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12. ABSTRACT (Maximum 200 words)

The objectives of this project have been: 1) to create a millisecond accuracy software timer module that could be incorporated into OMPAT and other testing programs, 2) to construct a set of automated, i.e., "computerized" OMPAT Level I neuropsychological and psychomotor tests with documentation that provide a standardized, clinically relevant, and rapid method for assessment of nervous system integrity, 3) to construct a version of UTCPAB that incorporates the software timer.

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1. INTRODUCTION

This final report provides a summary of work completed for the development of the Neuropsychological/Psychomotor Performance Evaluation and timing support programs. This effort took place at the Navy Computer and Telecommunications Station, Pensacola, FL.

The objective of this project was to create a library of computerized clinically relevant psychomotor and neuropsychological assessment tests that could be used as stand alone modules or be configured in a battery. The library of tests can be used for rapid assessment of nervous system integrity and is easily configurable, adaptive and dynamic in structure, providing computerized assessment tools for researchers and clinicians in both the military and civilian environment.

Hardware objectives for this library of tests were simplistic by design, requiring no additional computer equipment other than a standard IBM AT compatible personal computer.

2. METHODS

The Neuropsychological Performance Evaluation was designed to meet the specifications of the Level I TAG. All software include timing modules that provide millisecond accuracy for all patient/subject response times. Each individual test is consistent in software structure, data output formats, and method of use. Standardized test configuration switches are available in all test so that researchers and clinicians may tailor the test to the performance measure required.

Methodology for software design was based on the concept that computerized testing of human performance could be achieved for a wide range of performance abilities using the same set of software. The software should be very adaptable and dynamic in structure providing tests that can be easily modified by the user to measure performance at various levels. Software that can adapt to the patient or subjects abilities as they perform the test helps to break the paradigm of special tests for the high performer/low performer spectrum.

Standard features incorporated into the software include:

- 1) User intervention and control of test instructions, subject feedback, number of stimulus displayed, interstimulus gaps, length of stimulus presentation.
- 2) Multilingual usage. Language orientation may be controlled by the user. Language specific software items are located outside of the software modules, so they may be modified by the user. References to test response devices are done with visual aides, so that language barriers are negated.
- 3) All software may be used on a local area network. This feature provides security and dependability for researchers testing large populations of subjects.
- 4) Sensitivity to multiple stressors, i.e., heat, cold and fatigue on neurological functions, as well as, the interactive and independent effects of chemical agents and pharmaceuticals.
- 5) A variety of neuropsychological tests, in order to test a large domain of neuropsychological functions, i.e., sensory, perceptual and cognitive abilities.
- 6) User control of test order, stimulus randomization, quantity and type of data collected, location of data storage, size of stimulus displayed, etc.

3. RESULTS

Neuropsychological performance evaluation software was developed that can be used on standard IBM AT compatible personal computers. The Automated Neuropsychological Assessment Metrics (ANAM) and Tester's Workbench (TWB) are both libraries of compatible, standardized, adaptable, configurable tests that can be used in conjunction with each other or with other tests batteries. This software provides computerized screening for deficits in attention, memory, verbal skills, spatial skills and motor performance.

Various software utilities were written to complement the testing software. These utilities provide users with the ability to graph their data, change data formats so the data may be used in a variety of statistical packages. For the clinician, viewing programs provide quick displays of patient data and several different displays are available.

Compatibility and standardization of individual tests software, combined with a generic menuing system, allow multiple test batteries to be created to meet the needs of most neuropsychological measurements.

4. CONCLUSIONS

Computerized human performance neuropsychological assessment tools are gaining wide acceptance with both researchers and clinicians. Evaluation software that is adaptable, dynamic and easily configurable has made the computer a viable tool for evaluation of head injury patients and measuring various stressors on pilots and military personnel in a variety of situations.

In the past, computerized performance assessment software was created for each unique application of research. Although similar psychological tests were used through the country, tests were seldom used in more than one location, as the unique research requirements were part of the software. Each time the research requirements changed, the software had to be modified. Creating performance software that a researcher or clinician can modify, broadened the use of computerized assessment tools. Five years ago, only those with research money were able to acquire the expertise necessary to create and use computerized tests. Additionally, creating software that requires no additional computer hardware components also lessened the barriers to these computerized tools.

Although the research world has vigorously pursued the use of computers in assessing human performance, introduction of flexible assessment software, combined with commonplace hardware requirements has enormously broadened the tools of the clinician.

The following excerpts are included to provide further information on the variety of uses for this software. They are from AMEDD Psychology Short Course Presentation May 24-28, 1993, Automated Neuropsychological Assessment: DOD Contributions, (Spector and Reeves, 1993).

" In 1984 a group of five experimental, neuropsychologists, and human-factors engineers met at the Naval Medical Research Institute with direction from the Tri-Service Joint Working Group on Drug Dependent Degradation in Military Performance (JWGD3) (which has since become the Office of Military Performance Assessment Technology (OMPAT)) to create a set of standardized tests for the purpose of assessing performance over time during repeated testing procedures. The purpose of the meeting was to review tests from the major and existing computerized batteries for selection in a standardized Tri-Service battery. It should be noted that appropriateness for repeated measures testing was a primary criterion for inclusion. During this

three-day meeting, Army, Navy, and Air Force psychologists produced specifications for the Unified Tri-Service Cognitive Performance Assessment Battery (UTCPAB), (Englund et. al., 1989, and Kane and Kay, 1992). Tests selected for inclusion in the UTCPAB had been developed independently by different laboratories with little concern about standardization or comparability of results, the purpose of the UTCPAB development was to reformat the selected tests to meet strict standardization criterion. The batteries that were reviewed included: 1) The Navy's Performance Evaluation Tests for Environmental Research (PETER) battery (Bittner, Carter, Kennedy, Harbeson & Krause, 1986); The Walter Reed Performance Assessment Battery (WRPAB) (Thorne, Genser, Sing & Hegge, 1985); The Naval Medical Research Institute Performance Assessment Battery (NMRI-PAB) (Schrot & Thomas, 1988; Thomas & Schrot, 1988); and the U.S. Air Force Criterion Task Set (CTS) (Shingledecker, 1984). The end result was selection of 27 tests for inclusion in the UTCPAB along with rules for standardization of these tests to support development of Tri-Service batteries.

Tests from the original JWGD3/OMPAT 1987 inventory have recently gone through a second and major evolution. The tests have been modified to permit millisecond accuracy in timing through the use of sophisticated software routines that eliminate the need for "add-on" timing boards. This modification has significantly increased the portability of the tests. They now run on laptop and notebook computers and are suitable for use in remote locations. In addition, the subject-response interface has been modified. Most tests now allow the use of a Microsoft or Logitech compatible mouse and are designed so that subjects can respond to test items by clicking either the left or right mouse button. This modification improved timing accuracy and simplified the task of interfacing the subject with the computer. The UTCPAB designation has been replaced and the general OMPAT library of tests is referred to as the Tester's WorkBench (TWB).

In addition, a special TWB subset, the Automated Neuropsychological Assessment Metrics (ANAM), has been developed to bridge the gap between performance and clinical applications of computer-based tests. ANAM has given OMPAT a collection of sensitive and sophisticated tests for use in assessing changes in performance resulting from either environmental

stressors, injury, or neurologic disease.

ANAM has been designed with emphasis on both clinical and experimental applications which require repeated measures testing. A large pool of test items together with pseudorandomization techniques give each test a large number of multiple forms. This permits ANAM tests to be used during extended baseline testing and for monitoring performance over extended periods of time. ANAM tests have been constructed as self-contained testing modules that can be easily re-configured and "fine-tuned" to compensate for individual differences and changes in environmental demands. Additionally, subject instructions are written as independent ASCII files that provide an easy mechanism for adaptation of tests for a multi-national or multi-cultural administration. The ANAM battery will be employed in this project and configured as a customized "NASA" subset designed for monitoring performance during extended missions in space.

The ANAM Batteries - Background & Research

The ANAM project began formally in 1990. The purpose of the project was to adapt a subset of OMPAT developed tests for neuropsychological assessment and make them available to clinicians working in medical settings (Kane and Kay, 1992). While a number of useful neuropsychological measures had been developed for assessing patients with neuro-cognitive impairment (Kane, 1991; Lezak, 1983), clinicians were not able to take full advantage of the standardization, range of tasks, and timing accuracy afforded by the computer (Kane & Kay, 1992). It was felt that a tool like ANAM could significantly augment traditional clinical testing procedures. In addition, the need to assess patients in a serial manner was becoming an increasingly important task in neuropsychology. Serial assessment was important for monitoring medication effects, tracking the progression of and recovery from disease, and in treatment research. Traditional neuropsychological tests were not developed with these repeated measures uses in mind. Consequently, the time appeared right to bridge the arbitrary gap between clinical neuropsychological and laboratory performance assessment.

Initially, ANAM was direct outgrowth of a UTCB spinoff, i.e., the AGARD-STRES Battery (Reeves et. al. 1991) which had been developed for environmental and

aerospace research by the North Atlantic Treaty Organization (NATO). However, ANAM subsequently evolved into a broader library of automated tests constructed to meet the need for precise measures of processing efficiency in a variety of cognitive domains among a wide variety of neurologically impaired patient groups.

The following is a listing of individual tests currently available in ANAM V3.0 batteries:

1. Subject Information Form
2. Stanford Sleep/Fatigue Scale
3. Simple Reaction Time
4. 2-Choice Reaction Time
5. Simultaneous-Spatial Processing Task
6. Successive-Spatial Processing Task
7. Procedural & Symbolic Reaction Time
8. Running Memory
9. Sternberg Memory Search Task (alphabet and symbols)
10. Extended Running Memory (Continuous Performance Task)
11. Unstable Tracking
12. Dual-Task (Combined Memory Search & Tracking)
13. Moodscale II (From the Walter Reed PAB)
14. Matching To Sample
15. Code Substitution & Delayed Memory Task
16. 4-Choice Reaction Time
17. Tapping
18. Pursuit Tracking
19. Tower of Hanoi (Tower Puzzle)
20. Stroop Color/Word Interference
21. Letter/Symbol/Digit Span Tests

ANAM has undergone a steady evolution and expansion since its inception in 1990. The present version includes a multi-level set of batteries designed for assessing fitness for duty in high functioning patients to diagnosis and assessment of patients functioning in the demented range of performance. The development has been guided by a continuous series of case studies involving patients referred from neurology and neurosurgery clinics in a variety of major medical centers such as the National Rehabilitation Hospital, Walter Reed Army Medical Center, the National Naval Medical Center, and Baltimore VA Medical Center.

As a result, ANAM is the only existing battery with

built-in concurrent validity, because the "patient's" and their disabilities directed the modifications necessary to make the ANAM subsets appropriate and sensitive enough for clinical use. Clinical adaptation of the battery has required modifications of the original tests such as larger stimulus displays, forced-pacing response-time deadlines, addition of simplified response devices such as the mouse, and a more flexible executive menuing system and analysis support programs. As a result, final standardization of the subtests has only recently been completed. Consequently, a limited number of investigations have been possible using the ANAM subsets. However, a review of the currently available data is presented below along with a list of studies currently underway using the ANAM battery.

Pertinent ANAM Studies

WRAMC/NIH

Customized subsets of ANAM are currently being used to track recovery from mild head injury and to assess efficacy of therapeutic interventions. One such study is a 7-Center Department of Defense-Veterans Administration joint head injury project. Here, ANAM subtests are being used to augment traditional metrics to determine the effectiveness of short-term interventions. The objective of this program is to accelerate recovery from mild head-injury and more rapidly return military personnel who have suffered mild closed head trauma back to work (Spector, Reeves, and Kay, 1992).

NNMC

AT the National Naval Medical Center, ANAM batteries are being used to track recovery of function in mild head injury patients undergoing computerized cognitive remediation. Here, the focus is on recovery of ability to sustain attention and concentration for extended periods (Reeves, D., Bleiberg, Spector, & Hegge, 1992).

NRH

Other related research is being conducted at the National Rehabilitation Research hospital and is concerned with quantifying an inconstancy effect often associated with mild head in high functioning patients. In this study (Bleiberg, et al 1993), only tests that are designed for repeated measures and assessment of cognitive processing efficiency have proven sensitive to detection of the more unpredictable but debilitating effects of head injury. These studies have included more than 44-repeated administrations of ANAM over a four-day period of observation.

Another study conducted at NRH demonstrated ANAM's sensitivity to the differential effects of pharmaceutical treatment drugs in a case study with a mild head injury patient. Here, the effects of Dexedrine, Ativan, and Placebo were compared over and extended multiple baseline study. ANAM clearly revealed a "performance-stabilizing" effect of dexidrine, as well as a debilitating effect of Ativin, and the normal erratic and unpredictable pattern of performance associated with the Placebo administrations.

Baltimore VA

ANAM is also being used at the Department of Veterans Affairs Medical Center in Baltimore as part of a study of the effects of being wounded with bullets made from depleted uranium. Subjects in this study are veterans from Dessert Storm.

NASA

ANAM has been used in a variety of investigations related to monitoring of cognitive status in both everyday and somewhat more exotic environments. For example, Wood and Holland (1992) (c.f. Reeves, Kane, & Wood, 1992) studied 3 divers who lived for 30 days in an undersea habitat in LaChalupa near Key Largo, FL. The divers lived in undersea quarters similar to those of the currently proposed for the NASA space station. They were given training on the ANAM standard level battery during several practice sessions on 3 consecutive days prior to entering the undersea habitat. They then took a practice and test version of the same ANAM battery, once-a-day, each morning of their prolonged undersea mission. While

living in the submersed habitat, the divers had various under water assignments which required them to put on SCUBA gear and leave the habitat. They were not allowed to return to the surface at any time during this 30 day period. Performance on a number of tests tended to stabilize quickly. Performance on these measures quickly improved with practice and then reached relatively stable asymptotic levels. Standard deviations of both reaction time and accuracy measures became less variable over time. Performance on other tests which were presumably more difficult demonstrated more sensitivity to state variables and therefore showed more variability. Test performance mirrored the divers' assigned job performance. They successfully completed all assignments during their 30 day underwater mission.

There was also evidence that the ANAM tests were sensitive to stress producing factors. At one point during the extended mission, divers were required to talk to the press by telephone from the habitat. There was also a camera there to transmit their pictures. They reported feeling anxious about this encounter with the media. On that day, changes in performance efficiency were notable in the ANAM data. This decreased efficiency was noted even on the measures previous which had become highly stabilized over repeated administrations.

Computer-based testing in specialized medical settings.

Certain medical conditions or procedures require continuous monitoring. Intervention effects must be identified rapidly or deterioration in the patient must be identified very rapidly. Reliability or validity issues that pertain to repeated measurement and neuropsychology as a whole are certainly amplified the shorter and more rapid the testing session. And finally, the physical and operational constraints require brevity and portability of testing.

Specialized medical settings refer to the neuroradiology special procedures suite and/or the neurosurgical operating room. What is so special about specialized medical settings?

Normal Pressure Hydrocephalus

One of the first uses of ANAM during special medical procedures involved pre- and post-high volume lumbar testing in Normal Pressure Hydrocephalus patients. In a particular subgroup of elderly patients, there are situations when there's an over-production of CSF or an inefficiency in the re-uptake of CSF such that intracranial pressure increases and the ventricles grow quite wide. There's a triad of symptoms associated with that and that is incontinence, gait abnormality, and cognitive disturbance, typically approximating a dilapidation of intellect or a subcortical dementia. Surgical intervention by means of a shunt can sometimes be effective for these patients. ANAM has been used as part of a battery designed help decide which patients may be candidates for surgical intervention.

A Case Example.

In one such case we had opportunity to use our automated tests with a gentleman who underwent a 48 cc. lumbar puncture and a withdrawal of 48 cc. of cerebral spinal fluid in an attempt to see whether there might be those changes in cognitive functioning that might predict future success of a shunt. We used a set of test's from an early version of the FAA CogScreen battery which are similar to the tests we've discussed thus far. This battery included visual matching-to-sample, sequence comparisons, a Manikin test, as well as some standard tests such as controlled oral fluency and verbal and non-verbal selective reminding procedures. We conducted baseline testing over a significant period of time, made sure that the individual had established some consistency, and then tested 4, 8, 12, 24, 28, 36, 48, and 72 hours after the lumbar puncture. It is generally the case that under normal conditions 48 cc of CSF should have been replaced in about 8 hours, but when you've punctured the lumbar system to insert the catheter for an LP, a hole is created that can takes a while to seal and the CSF pressure stays down for longer periods.

The general pattern of results from a successful trial generally reflects stable and unchanging accuracy levels. In contrast, reaction time is reduced during the immediate 4-12 hour post-LP period followed by a gradual slowing and return to baseline reaction time levels. The stable accuracy but reduced reaction time reflects what we believe is an improvement of cognitive processing efficiency which is what would be expected in a

temporarily resolving subcortical dementia produced by the high volume fluid withdrawal. The two tests that we have use thus far have been the Manikin and Matching-to-sample tests which require spatial processing and working memory along with a simple two choice motor response.

Balloon Trial Occlusion

Another special medical procedure for which ANAM has proven useful has been during pre-surgical balloon occlusion of the carotid artery in a procedure we refer to as a Balloon Trial Occlusion. The purpose of such a procedure is to try to predict whether or not it would be safe to occlude or clip a carotid artery in cases such as aneurysm surgery where extended occlusion would be required. An example of this is one of our cases in which a 40 year old active duty male service member with a large ophthalmic artery aneurysm. This type of aneurysm is difficult to resect under any circumstances and sometimes resecting them requires cutting off or ligating the feeders to the artery to include the internal carotid artery. An individual should be able to sustain ligation of the internal carotid artery if the Circle of Willis, that network of arteries underlying the brain, is intact. That's what permits collateral flow. In some individuals though, that might not be the case and you need to ascertain whether the Circle of Willis really can sustain cutting off the flow to the internal carotid artery before you go and ligate it and attempt to take out a lesion of that size. In such a case a Balloon Trial Occlusion procedure is recommended for making pre-surgical decisions.

In another illustrative case our patient was a 32-year-old gentleman with a giant aneurysm of the ophthalmic artery which would require sustained occlusion during surgery. In this case, we obtained stable pre-occlusion baseline measures with ANAM along with controlled oral fluency tests. We then conducted a repeated measures assessments at 6, 16, 27, and 36 minutes after the balloon was inserted into the left internal carotid artery and inflated. This essentially cut off blood supply to the left internal carotid artery. We then tested 6, 12, and 20 minutes after deflation because that's the period of time where there's a risk of vasospasm and shut down of the carotid artery functions

and then left internal carotid artery was ligated fourteen days after the trial occlusion when they did the resection of the ophthalmic artery aneurysm and we did follow-up testing six days after the ligation or a total of 20 days or so after the test occlusion. During this procedure we presented the test on a Notebook computer that was held about 14 inches from the patient's face. In addition, we used a standard Microsoft mouse as a response device which the patient held in his left hand, just in case performance might have been affected by the left ICA occlusion.

The general pattern of results show stable and unchanging accuracy levels with either an increase or a slight decrease (due to continuing practice effects) or reaction time. The Running Memory Continuous Performance Test is the test that has proven most useful in this procedure. Generally, reaction times on this test range between 450 to 650 ms. During inflation we have observed about a 100 ms increase (i.e., slowing) of reaction time with no observable negative effect. A return to or slightly better than baseline performance is expected immediately following deflation of the balloon.

Cortical Mapping

There's a long tradition of doing cognitive testing when neurosurgery is conducted during awake conditions for certain resections, particularly in a dominant hemisphere. One certainly maps motor functions, because of the devastating effects of inadvertent resection of motor cortex. The same applies to the language-related areas. There's an interest as well in the mapping of memory functions, or at least in those attentional functions that underlie memory. You can do that inter-operatively or you can implant subdural grid electrodes, take them back to a recovery room and test them at your leisure over a couple of days. Our procedure has been modeled after that used by Ken Perine and can be linked back to Pennfield. It consists of testing the awake patient, with the craniotomy on-going, while their brain is being stimulated. The patient's task is to identify, i.e., name, pictures of common objects, to read aloud a simple sentence, and then recall a previously named object. Future developments will include the running memory paradigm, which is to say the patients will be shown letters, one after the other, and they will respond by indicating whether the word is the same or different than the one that it immediately

preceded. This will allow us to have an on-going measure of attention and of the underlying cognitive function inter-operatively.

CABG

There exist questions within cardio-thoracic surgery as to whether conducting surgery under certain conditions vs. others affects the eventual outcome. It's current debate concerning the issue of whether to do open heart surgery and keep the blood warm to body temperature, or whether it should be cooled to about 4-5 degrees Celsius below normal body temperature. There exists a belief that oxygen requirements are lower when the blood's temperature is lower versus the oxygenation of the brain is better when the blood is at body temperature. It was recommended that CABG procedures be performed under either normothermic or hypothermic conditions and that patients be randomly assigned. In a study recently conducted at WRAMC, patients were given a subset of ANAM pre- and post-surgery. Here the patient's were given baseline tests about three hours prior to surgery, and then they were re-tested six and thirty days post-surgery. The battery in this study included the Sternberg Memory Task and Running Memory. Results from this pilot study that included 20 subjects revealed no significant differences related to surgical conditions. The question asked of the neuropsychologist was, was there anything occurring in this study that would suggest that the more formal double-blind study be discontinued. As it turned out, we found no negative effects associated with the experimental procedures and as a result the 100-patient study is currently on-going.

Other potential clinical applications: ADHD.

During his presentation at the AMEDD Course, Dr. Jeff Barth discussed the potential effect of Ritalin on attention and traumatically brain injured adults and the issues concerning repeated measures using computer based testing with reaction time which gives you a real opportunity to look at the short term changes that occur due to medication. Some, such as Ritalin are very short acting, i.e., it has its affect and clears the system in a matter of hours. , such as most of the stimulus that we're talking about. We're also talking about the use of these types of measures, which for the most part have yes

or no, same or different, dichotomous response opportunities for the detection for factitious memory and attention deficits in unsubstantiated head injuries.

General Clinical Application Guidelines

The ANAM batteries were not originally designed as stand-alone screening instruments, rather they've been created with the intent of augmenting standard batteries. ANAM provides a means for assessing cognitive processing efficiency in a variety of attention/concentration paradigms that also involve spatial processing, mental flexibility, and working memory.

There are several ways of integrating ANAM into a standard assessment routine. The one we recommend and have found most useful is to begin an assessment session with an orientation/practice battery and then three full administrations of one of the four ANAM batteries. Then during administration of the more traditional tests, re-administer the running memory CPT every ninety minute intervals to track the patients level of efficiency throughout your more comprehensive assessment.

As it turns out most patients can be administered one of the practice batteries in about 10 minutes, thereafter a standard administration of the regular batteries takes about 20 minutes per administration. The reason we recommend three administrations is because there will be a learning curve and three data points is the minimum necessary to plot such a curve. Another opportune time for interleaving the ANAM administrations in a more traditional assessment is to implement it during MMPI testing. Here, you can interrupt MMPI or other similar personality tests give the patients an ANAM-administration break every 30 minutes, i.e., they can take a 20 minute battery and then go back to filling the dots on the MMPI or similar forms. We have found that this routine actually provides for more valid MMPI profiles because the break raises their level of arousal and they don't get so bored during the test and take it more conscientiously.

Performance in normal individuals generally very stable across many trials, even when the test-retest interval is extended to weeks or months. Some tests are harder than others and you can see the difference in both reaction-time and throughput scores. When efficiency and/or

concentration levels drop, reaction times slow and the standard deviation of the reaction time increases, i.e., the patient/subject's performance becomes variable.

What we've presented in this paper is only the "tip of the iceberg". We've focused primarily on ANAM, but there's much more in the OMPAT inventory of psychometrics. We hope this has peaked your curiosity and invite the readers to participate in our assessment "free" enterprise.

ANAM TEST DESCRIPTIONS

The following are abbreviated descriptions of a sample of the ANAM tests. Many of the test descriptions that follow were derived from AGARDograph No. 308 (1989), Reeves, et. al.(1991), and Englund et. al., (1987). The reader is referred to these publications and the TWB documentation for a complete list of descriptions and illustrations of the many tests.

1. INFORM

All of the ANAM batteries begin by presenting the administrator with the opportunity to record subject/patient demographic data. This is accomplished through the use of the INFORMATION questionnaire that is automatically displayed each time a battery is initialized. This program prompts for items such as Subject ID, AGE, SEX, OCCUPATION, DIAGNOSIS, etc. and allow three lines for writing special comments, e.g., "This person just had an accident before they took the test today and I think it might affect their performance".

2. Stanford Sleepiness Scale-Modified.

The second program displayed in most ANAM batteries is the modified Stanford Sleepiness Scale. This scale allows the assessment of the patient/subject's subjective energy and somnolence level. The scale originally used several words that many of our patients didn't understand, the word "modification" in the title refers to a simplification of the statements in the scale. The scale consists of seven statements that describe how one feels with respect to alertness or sleepiness. The original version was created and validated by Hoddes, et. al. (1973). The version used in ANAM was derived from the WRAIR PAB, Throne et. al. (1985).

3. Mood Scale 2

This test was derived from a paper-and-pencil adjective check list developed by Ryman, Biersner, and LaRocco (1973). The automated version used in ANAM was originally derived from the Walter Reed Performance Assessment Battery, Throne et. al. (1985). It consists of a listing of 36 adjectives that are rated on a three point scale with respect to how they apply to the person taking the test. In this test one is requested to

respond to each adjective with respect to how it describes how one feels. It may be used as either a "state" or "trait" test depending on the instruction set. In ANAM it is included as a "state" test. Six scales are produced from the response set. These are, Anger, Happiness, Fear, Depression, Activity, and Fatigue.

This check list is similar in format and purpose to the Profile of Mood States(POMS) and Multiple Affect Adjective Check List (MAACL). It also has a scale that I've been running against the Beck Depression Inventory and the correlations are very high.

4. SIMPLE AND 2-CHOICE REACTION TIME.

These tests simply display a stimulus on the screen, e.g., (*), or (* o) and the subject presses a designated response key each time they see the stimulus.

Although surprisingly simplistic as their name implies, these reaction time measures, simple reaction in particular, has proven quite useful as a basic reference marker for subtracting out the motor component from the more cognitively-loaded ANAM tests. Further, simple reaction is as about as close as one can get to a performance measure based index of neuron conduction velocity because it requires almost no cognitive interaction.

5. MEMORY SEARCH (modified Sternberg Memory task)

This task is based on the classic paradigm described by Sternberg (1969). A set of letters is displayed horizontally in the center of the monitor. This is the "memory" set and the subject is asked to view it until it is memorized. Next, single "probe" letters are presented in the center of the screen, one at a time. The subject indicates whether the probe letter is the same as any of the letters in the memory set or if it is different from the memory-set letters. Responses are entered by pressing a specified key or mouse button.

MEMORY SEARCH-SYMBOL VERSION

The military is well noted for the use of acronyms. As a result it's difficult to create multiple letter combinations that don't stand as an abbreviation for something in DOD. With respect to the Sternberg Memory

Search task, this situation creates a major potential confounding variable. That is, if a letter combination is a familiar acronym the next one isn't then the first will be easier to remember and thus facilitates test performance. As a result we have created an alternative version, i.e., a Symbol-based Sternberg paradigm. In this test the paradigm remains the same, but the letters are replaced by symbols. Although some of the symbols can still be named things such as a "Whatchamacallit" or "gizmo" it's much harder to create an acronym out of them. Thus this potential source of confounding is controlled and the test becomes much more a spatial working memory task. The possibility exists that it may even localize to the right hemisphere.

6. MATHEMATICAL PROCESSING

During this task subjects perform two mathematical operations (addition and/or subtraction) on sets of three single-digit numbers (e.g., $5 + 3 - 4 = ?$). The subject is instructed to calculate and determine whether the answer is greater than or less than five. A specified keypress indicates less than or greater than five.

7. SPATIAL PROCESSING (Simultaneous and Successive)

During this test, pairs of four-bar histograms are presented either simultaneously or successively on the monitor. The barographs are presented as pairs and the subject is requested to determine whether they are identical. One histogram is always rotated either 90 or 270 degrees with respect to the other histogram. The subject responds by pressing a specified key or mouse button to indicate that the two histograms either match or don't match. The simultaneous version of the task constitutes a spatial processing and mental rotation task; the successive version adds a working memory component.

8. Matching to Sample.

Matching to Sample is a test that was originally derived from the NMRI PAB and has proven useful in screening aviators in the version used in the FAA's

CogScreen (Kane and Kay, 1992). In this test the patient/subject is required to select one of two patterned matrices that match a previously displayed sample matrix. A single 4 x 4 matrix (i.e., checkerboard) is initially presented in the center of the screen as a sample stimulus to the subject. For each presentation the number of cells that are shaded in each matrix vary at random from only 3 to 13 cells. After the initial sample matrix has been presented, it is removed and after a specified time interval, two comparison matrices are displayed side-by-side. One of the comparison matrices will match the "sample" matrix the other comparison matrix will differ in shading from the "sample" by one cell. The patient/subject's task is to indicate by pressing the appropriate response button, which comparison matrix matches the "sample" matrix.

9. RUNNING MEMORY (STANDARD AND CONTINUOUS PERFORMANCE TEST).

Running memory is a continuous letter comparison task (Stanny, In Press). In the running-memory task, subjects are asked to monitor a randomized sequence of upper-case letters, A through Z. The letters are presented one at a time in the center of the screen. Subjects are asked to continuously monitor the letters and press a specified button if the letter on the screen matches the letter that immediately preceded it. They are requested to press a different specified response button or key if the letter doesn't match the immediately preceding letter. This task is extended to approximately five minutes duration in the Continuous Performance Test Battery.

Running memory is one of ANAM's most sensitive tests as well as the most challenging. It is similar in format to Gronwall's (Gronwall and Sampson, 1974) Paced Auditory Serial Addition Test in that it is forced paced and requires continuous high-level updating of working memory. It is primarily a sustained attention/concentration task.

10. PROCEDURAL REACTION TIME (MODIFIED STRES REACTION TIME)

This is a shifting mental set and attention/working memory test. In this task, digits (2, 3, 4, and 5) are presented in the center of the monitor, one at a time. The subject is requested to respond to the digits 2 and 3 depressing a specified key or mouse button and to respond to displays of 4 and 5 by depressing a different

specified key or button. Two version of this test are available in ANAM. In one version the letters are clearly discernable, and in the other they are distorted adding a visual-spatial discrimination component.

11. UNSTABLE TRACKING

This is a continuous visuo-motor tracking task which follows a compensatory tracking format. During the test, a if forced off-center of the monitor's screen continuously. The patient/subject's task is to move the mouse in the opposite direction of the cursor's movement in attempt to maintain the cursor's position in the center of the screen. The test has a built-in instability algorithm that work's against the patient/subject to keep the cursor from remaining in the center of the screen. A good analogy to this task can be conceptualized by trying to balance a ball in the center of a see-saw.

With respect to flight and military systems, visual-manual tracking skills are important to those who are concerned about operation of "stick and rudder" systems. The tracking task has been used for many years in aviator selection, hence, our version holds promise as a flight readiness assessment metric.

12. DUAL TASK (Sternberg Task + Unstable Tracking)

This test is a combination of the Unstable Tracking and Memory Search tests. Both tests are presented the same way as they are when run separately. However, in this task they are presented simultaneously. The subject is instructed to pay equal attention to both tasks. Here the issue is that of multi-tasking and the extrapolation to systems in which one has to do more than one thing at a time is intuitive.

ANAM Special Features

Several features of the ANAM batteries set them apart from other similar batteries. These include options such as large screen displays, four levels of difficulty, as well as considerable flexibility regarding the modifiability of the configuration. Some of these features are further discussed below.

Standardized Instruction Screens.

ANAM batteries present standardized instruction in bigger than normal lettering to compensate for visually impaired patients who frequently have lost or forgot to bring their glasses with them to the clinic. In addition, special effort has been made to make instructions simple and easily translatable into other languages. A Spanish version for many tests currently exists.

About the MOUSE

Most ANAM tests have been designed for use with a Logitech or Microsoft Serial Port Mouse. We have found that this makes the tests appropriate by almost any age or type of patient. That is the tests require only the pressing of one of two buttons to respond during a given test.

Feedback about Results and On-line Accuracy

All ANAM tests allow the administrator to specify one of two types of feedback. One is on-line, item-by-item feedback. Here, a "smiley" or "frowny" face may be specified to appear following each response thereby indicating to the patient/subject whether their answer was correct or incorrect. In addition, one may specify that the test display summary results, i.e., percent accuracy and mean response time at the end of each test.

The decision of whether to use feedback or not and what type is a highly individual and paradigm directed issue. Therefore, we have made this an option rather than a "hard-coded" requirement within each test. General rules are that when running "normal" subjects in trials where you want to motivate them to do their best, providing "end-of-test" feedback usually facilitates efforts to get their "best" performance. On the other hand, early-onset dementia patients' performance may be adversely effected by feedback that may show unwanted impaired performance, and therefore is contraindicated."

APPENDIX I

TECHNOLOGY TRANSFER

TRANSFERS MADE DURING FY93.

Transferred human performance neuropsychological testing software:

Aberdeen Proving Grounds, MD

Occupational Physiology Dept., USARIEM, Natick, Massachusetts.

Navy Biodynamics Laboratory, New Orleans, LA.

National Institute of Health, Bethesda, MD and provided phone consultation.

Dept. of Kinesiology, Louisiana State University.

University of Rochester Medical Center, Rochester, NY.

Dr. M.B. Sterman, Sepulveda, CA.

Veterans Administration Hospital, Kansas City, MO.

Logicon Technical Services, Wright-Patterson AFB, Dayton, OH.

Thomas Jefferson University, Philadelphia, PA, also provided onsite training.

FAA, CMAI-AAM, Oklahoma City, OK.

Neurology Department, Hannemann University, PA, also provided onsite training.

Dr. Sullivan, Johnson City, TN.

Psychological Services, VA Medical Center, Bedford, MA.

Department of Neurology, Hospital for Joint Diseases, New York City, NY.

Medical College of Georgia, Section of Behavioral Neurology, Augusta, GA.

Clinical Technology Associates, Elmsford, NY.

Dr. Ben Williams, for assessment of Attention Deficit Disorders, Houston, TX.

Dr. Jerry Gamache, St. Augustine, FL.

Dr. Robert Kane, VA Hospital, Baltimore, MD
for use both clinically and in a study for effects of uranium depletion.

Dr. Glenwood Brooks, Jr., Baltimore, MD.

Dr. Marsha Cohen, West Hartford, CT.

Dr. Joseph Francis, Psychology Dept., NSWDG, Virginia Beach, VA.

Dr. Daniel Gardner, Washburn, WI.

Dr. Arline Goldstone, Abington Memorial Hospital, Dept of Rehabilitation Medicine, Abington, PA.

Dr. James Karpawich, Akron, OH.

Dr. Suzanne Martin, Colorado Springs, CO.

Russel Newton, Columbia, MO.

Maureen O'Mara, Vienna, VA.

Dr. John Pittner, APO, AE

Dr. Eugene Carway, III, Houston, TX.

Dr. Marvin Denburg, Oneonta, NY.

Allan Frol, Dallas, TX.

Dr. John Gentry, Chalfont, PA.

Dr. Tazewell Jones, Montgomery, AL

Dr. Janiece Lord-Maes, Tucson, AZ.

Dr. David Moyerman, Columbus, GA.

Dr. Micahel O'Connell, Medford, OR.

Martin Petrillo, Naval Hospital, FPO, AE.

Richard Sekula, Erie, PA.
Dr. Jeanett Sharp, Albany, NY.
Dr. Gerald Stein, Brook Clinic Associates, Oak Brook, IL.
Dr. Rodney Sullivan, Johnson City, TN.
Charles Turek, VA Medical Center, Psychology Services, Buffalo, NY.
Dr. Sally Skewis, Reno, NV.
Dr. Douglas Streich, South Bend, IN.
Dr. Susan Toole, Dayton, OH.
Dr. Larry Vaught, Tulsa, OK.
Dr. Mark Altomari, Columbia, MO.
Donna Baumgartner, Columbia, MO.
Mary Gerkovich, Prairie Village, KS.
Dr. Steven Hoffman, Overland Park, KS.
Dr. Brick Johnstone, Fulton, MO.
Dr. Gary Kitto, Sedalia, MO.
Dr. Virginia Bruce-Wolfe, Overland Park, KS.
Dr. Stanley Butts, Shawnee, KS.
Dr. E. Thomas Copeland, Kansas City, MO.
Dr. John Dolenz, Topeka, KS.
Dr. Bill Geis, Kansas City, MO.
Dr. Barrett Halderman, Salina, KS.
Dr. Larry Hays, McPherson, KS.
Dr. John Helton, Wichita, KS.
Dr. Ward Lawson, Nevada, MO.
Michael Salinger, Clinton, MO.

Dr. Dean Skadeland, Kansas City, MO.
Dr. Ronald Szymankowski, Roeland Park, KS.
Dr. Robert Whitten, Pittsburg, KS.
Roger Wise, Nevada, MO.
Bart Andrews, St. Louis, MO.
Dr. Laura Baker, St. Louis, MO.
Dr. Herbert Berger, St. Louis, MO.
Dr. Steven Berger, St. Louis, MO.
Dr. Donna Campbell, St. Louis, MO.
Dr. Fred Carrington, Russellville, AR.
Dr. Meena Dhawan, St. Louis, MO.
Sandra Carusa, St. Louis, MO.
Dr. Gerard Erker, St. Louis, MO.
Buz Ferrell, Benton, MO.
Dr. Jacque Fiedler, Vinton, IA.
Dr. Louise Flood, Cape Gerardeau, MO.
Lisa Gottlieb, St. Louis, MO.
Tamara Hershey, St. Louis, MO.
Dr. Leopold Hofstatter, St. Louis, MO.
Stephen Kanne, St. Louis, MO.
Dr. Arthur Kemp, St. Louis, MO.
Dr. Joseph Maciejko, Bettendorf, IA.
Dr. David McEchron, Bettendorf, IA.
Dr. Robert McGilligan, St. Louis, MO.
Larry Michaels, Farmington, MO.

Dr. Michael Oliveri, St. Louis, MO.

Dr. Wendell Rivers, St. Louis, MO.

Jeffrey Schatz, St. Louis, MO.

Dr. William Schicht, St. Louis, MO.

Dr. Linda Sharpe-Taylor, St. Louis, MO.

John Stock, St. Louis, MO.

Dr. Ed Tamberino, Nashville, TN.

Dr. Margaret Tamberino, Nashville, TN.

Dr. Danny Wedding, Missouri Institute of Mental Health, St. Louis, MO.

Dr. Holly Weems, St. Louis, MO.

TRANSFERS MADE DURING FY92.

Software updates are still being requested.

Transferred upgraded ANAM/UTC-PAB/STRES software to USAFSAM Brooks AFB, San Antonio for use in performance testing for the IML-2 space shuttle launch of January 1994.

Transferred human performance neuropsychological testing software to the National Institute of Health for use in clinical evaluations. Provided onsite training.

Transferred human performance neuropsychological testing software to the National Naval Medical Center, Bethesda, MD for use in clinical evaluations. Provided onsite training.

Transferred human performance neuropsychological testing software to the Walter Reed Army Hospital, Washington, DC for use in clinical evaluations. Provided onsite training.

Transferred human performance neuropsychological testing software to Krug International Life Sciences (Behavior and Performance Laboratory at Johnson Space Center, Houston) for use in NASA's underwater habitation research program which took place at the Jules' Undersea Lodge in Key Largo, FL, May 1992. Performance software was used to measure stress effects of confinement on aquanauts.

Transferred human performance neuropsychological testing software to Edward Philpot, MD, Vacaville, CA.

Transferred human performance neuropsychological testing software to Group Health Inc., Mental Health Center, Minneapolis, MN for use in clinical evaluations.

Transfers made during FY91, software updates are still being requested by the following:

Transferred human performance neuropsychological testing software to NAMI, Pensacola NAS for evaluation. Provided onsite installation and training.

Transferred human performance neuropsychological testing software to NBDL, New Orleans NAS for use in ship motion research. A setup, installation procedure and software demonstration was provided at Pensacola NAS.

Transferred human performance neuropsychological testing software to USAARL, Ft Rucker for human performance research. A demonstration of software and installation procedures was provided at Pensacola NAS.

Transferred upgraded STRES software to NAMRL, Pensacola NAS for use in sustained operations performance testing.

Transferred upgraded STRES software to USAFSAM Brooks AFB, San Antonio for use in performance testing.

Transferred human performance neuropsychological testing software to National Rehabilitation Hospital, Washington, DC for evaluation of brain injury patients. A setup, installation and demonstration of software was provided at NRH.

Transferred human performance neuropsychological testing software to Krug International Life Sciences to support ongoing NASA research at the Johnson Space Center, Houston, TX.

Transferred human performance neuropsychological testing software to the University of Massachusetts Medical Center to support ongoing research in neuropsychological assessment. A setup, installation and demonstration of software was provided.

Transferred human performance neuropsychological testing software

to Georgetown University Medical Center, Department of Neurology, Washington, DC to support neurodiagnostic procedures. A setup, installation and demonstration of software was provided at GU.

APPENDIX II

PERSONNEL PERFORMING WORK ON MIPR 91MM1504

Sam LaCour

Steve Messick

Kathy Raynsford

Steve Watkins

Kathy Winter

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